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Division of Plant Industry

THE BURROWING NEMATODE
RADOPHOLUS SIMILIS (COBB 1893) THORNE 1949

J. B. MacGowan

Fig. 1 Citrus tree infected with burrowing nematode and showing symptoms of spreading decline.

HISTORICAL:

The burrowing nematode, Radopholus similis (Cobb 1893) Thorne 1949, is widely known as a destructive pest of citrus, black pepper, and banana. It is an active parasite on more than 250 different species of plants throughout the tropical and semi-tropical world.

The burrowing nematode was first observed by Dr. N. A. Cobb in 1891 in New South Wales as he examined diseased banana roots which had been shipped to him from Fiji. The burrowing nematode has been found in North America, Central and South America, the Caribbean, Africa, Australia, Oceania, and Asia. It is credited with having nearly destroyed the agricultural industry of Bangka, an Indonesian island larger than Puerto Rico. Black pepper was the major agricultural resource of that island. The disease called pepper yellows, caused by the burrowing nematode, appeared in the 1930's. By 1950 only 2 million pepper plantings remained of an industry which once boasted 22 million plantings. The burrowing nematode is probably most widely known as a pathogen of banana on which it can suppress fruit yield as much as 50%.

In Florida, it is best known as the causal agent of spreading decline, a disease of citrus which can cause a 40-80% fruit loss. Spreading decline was first observed in a Florida citrus grove in 1928. A campaign begun in 1939 to find the cause of spreading decline ended in 1953 when Drs. R. F. Suit and E. P. DuCharme identified burrowing nematode as the causal agent.

DIAGNOSTIC CHARACTERISTICS:

The female burrowing nematode is 650-800µm long by 20-24µm in diameter. The vulva is located approximately 54% of body length from the head. The head is rounded and slightly flattened, offset by a slight constriction, and is supported by a sclerotized framework. The stylet, 18µm long, is plainly visible, and has prominent knobs. The esophageal glands overlap the intestine dorsally. The tail shape is elongate conoid.

Males do not resemble females in gross appearance. They are 500-600µm long and more slender than the females. The head, set off by a conspicuous constriction, is well rounded and non-sclerotized. The stylet is quite slender and indistinct, 12µm long, and has small knobs which are difficult to see.

There are two races of burrowing nematodes in Florida which appear to be morphologically indistinguishable. They are separated by their host preferences. One race feeds on both bananas and citrus and is believed to exist only in the state of Florida. The other race feeds on banana and does not feed on citrus.

ABOVEGROUND SYMPTOMS:

The severity of the symptoms of spreading decline will vary with environmental factors. Citrus trees growing in the well-drained deep sandy ridge area of Florida are more adversely affected than those growing in the wetter heavier organic soils.

Spreading decline areas can be easily delineated by visual symptoms. Symptoms usually appear about a year after infection. Infected trees have sparse foliage, retarded terminal growth, and poor color. There will be twig dieback and a general unthriftiness. Leaves may wilt at midday but show temporary rejuvenation with rain or irrigation. There may be little or no new growth during spring flush. Trees may bloom profusely but bear only a few small fruit. Trees will appear undernourished without exhibiting specific symptoms of malnutrition. A fruit yield suppression of 40-80% can be expected. As a rule, grapefruit trees appear to be more adversely affected than orange trees. Distinctive symptoms of spreading decline seldom appear on non-citrus plants infected with burrowing nematode.

Contribution No. 165, Bureau of Nematology, P. O. Box 1269, Gainesville, Florida 32602

BELOWGROUND:

The destruction of a significant portion of the feeder root system below a dept of about 20 inches brings about the aboveground symptoms. A citrus tree infected with the burrowing nematode has about 1/2 as many functional feeder roots as a healthy tree and these are usually in the top 24-30 inches of soil. Ninety percent of the feeder roots are destroyed below 30 inches. In the upper 10 inches of soil the feeder roots of both the healthy and infected trees appear the same and there is virtually no nematode activity. Below this depth the roots invaded by nematodes are heavily lesioned. Root destruction results from physical damage of the nematodes' burrowing and feeding action, from root reaction to nematode metabolites, and from invasion of secondary pathogens.

LIFE CYCLE - BIOLOGY:

The egg to egg life cycle of the burrowing nematode is usually completed within 3 weeks. All stages are found inside the root. The nematode punctures the root epidermis cells with it stylet, digesting and sucking the cell contents as it burrows into the root. Entry is usually at the root tip or in the region of root hair production and takes less than 24 hours. The burrowing nematode attacks only tender young feeder roots and not hardened, suberized, senescing, or decayed roots. The optimum depth at which nematodes feed on citrus roots is 30 inches. Roots in the top 12-18 inches remain functional. The greatest populations of burrowing nematodes are at depths of 1-6 feet and as deep as 12 feet. These nematodes are usually not found in the top 6 inches of soil.

Once inside the root, the worms feed and reproduce. The male, with its rudimentary stylet, is not known to penetrate roots nor to injure them to any extent.

Females and larvae feed on roots. Females may lay 1-6 eggs a day inside the roots. Lesions formed as a result of nematode activity enlarge, coalesce, and begin to die. Nematodes will at this point, or because of population pressure, leave the root and migrate into the soil. Root destruction can be so rapid that nematode reproduction is hampered. During this migratory stage while the worm is seeking a new food source of healthy roots, the area of infestation spreads to adjacent trees.

The burrowing nematodes' ability to survive adversity is enhanced by 3 factors: (1) an extensive host range, (2) a short life cycle allowing rapid reproduction during favorable periods, and (3) the ability of females to reproduce for one or two generations without males.

In Florida, the highest burrowing nematode population levels in citrus roots are found in October through December. The lowest population levels are found from January through July. Root samples taken in August through January offer the best chance for a positive burrowing nematode recovery.

TRANSMISSION AND SPREAD:

The principle means of burrowing nematode transmission to new localities, including citrus groves, is by the movement of infected plants. Once the nematode is established, the resultant symptoms of spreading decline can move through the grove at an average of 40-50 feet a year. soil drainage will affect the rate and direction of spread. It moves slower spreading uphill and faster downhill.

The nematode can cross gaps between citrus trees where roots make contact or near contact. The roots of a healthy citrus tree can extend 70 feet from the trunk. Nematodes can travel from grove to grove on weeds and wild hosts. They can cross under paved roadways. We do not know how far a burrowing nematode can travel through the soil to establish infection in another plant.

Nematodes are also spread with soil which may be carried from one area to another whether in bulk or on the treads of agricultural equipment. Surface water movement will transport nematodes from grove to grove. Nematodes brought in on infected plants to homesites which border citrus properties become a reservoir of potential infection for the citrus.

The burrowing nematode is tough and adaptable. Its extensive host range, endoparasitic habit, small size, and demonstrated mobility challenge control efforts.

SELECTED REFERENCES:

Christie, J. R. 1959. Plant nematodes, their bionomics and control. Agric. Exp. Sta., Univ. of Fla., Gainesville. 256p.

DuCharme, E. P. 1954. Cause and nature of spreading decline of citrus. The Citrus Industry 35(11): 6-7, 18; and 35(12):5-7.

DuCharme, E. P., and W. Birchfield. 1956. Physiologic races of the burrowing nematode. Phytopathology 45:615-616.

O'Bannon, J. H. 1977. Worldwide dissemination of Radopholus similis and its importance in crop production. J. Nematol. 9(1):16-25.

O'Bannon, J. H., and A. T. Tomerlin. 1971. Response of citrus seedlings to Radopholus similis in two soils. J. Nematol. 3(3):255-260.

Poucher, C., H. W. Ford, R. F. Suit, and E. P. DuCharme. 1967. Burrowing nematode in citrus. Fla. Dept. Agric. and Consumer Serv., Div. of Plant Industry. Bull. no. 7. 63p.

Suit, R. F., and E. P. DuCharme. 1953. The burrowing nematode and other parasitic nematodes in relation to spreading decline of citrus. Plant Dis. Reptr. 37(7):379-383.

Taylor, A. L. 1969. The Fiji banana-root nematode, Radopholus similis. Proc. Helminthol. Soc. Wash. 36(2):157-163.